practical applications in NMR, however, ρ may be set equal to the maximum value of a region occupied by the sample. For an NMR tube of radius 5mm, for example, ρ may be set equal to 2.5mm.

A1 End

IN THE CLAIMS

Sub C1

1.(amended) An extended Maxwell pair comprising:

a pair of cylindrical gradient coils disposed coaxially around and along a z-axis extending in z-direction and symmetrically with respect to an origin, each being of radius a and of axial length d, said pair being mutually separated by a center-to-center distance $z_0$ which is greater than d; and

A2

means for causing equal magnitude currents to flow through said gradient coils in mutually opposite directions;

values of d and $z_0$ being selected such that said equal currents generate a magnetic field along said z-axis with a linear gradient near said origin in said z-direction.

a pair of cylindrical shield coils disposed coaxially around said gradient coils, each of said shield coils being of radius b which is greater than a, said means causing said equal magnitude currents to flow through said shield coils, said shield coils serving to cancel magnetic field outside said shield coils.

Please cancel claim 2 without prejudice

Please cancel claim 4 without prejudice

Please cancel claim 6 without prejudice

Sub C1

A3

7.(amended) The extended Maxwell pair of claim 5 wherein each of said shield coils comprises a wire which is wound cylindrically at specified intervals, said intervals being determined such that said shield coils have effects of canceling magnetic field external to said shield coils.

Cont

8.(amended). The extended Maxwell pair of claim 1 wherein a and d are of the same order of

Sub C4 Cont

magnitude.

9.(amended) The extended Maxwell pair of claim 1 wherein a, b, d and $z_0$ satisfy an equation given by $\int_0^{k_{max}} dk k^4 \{\sin(kd/2)\sin(kz_0/2)/(kd/2)\} S_0(k) K_0'(ka) I_0(k_\rho)=0$ where $S_0(k)=1-K_1(kb)I_1(ka)/K_1(ka)I_1(kb)$, $I_1$ and $K_1$ are modified Bessel functions, $k_{max}$ is an appropriately selected upper limit of integration and $\rho$ is an appropriately selected value less than a.

Sub C1

11.(amended) A method of designing an extended Maxwell pair, said extended Maxwell pair comprising:

a pair of cylindrical gradient coil surfaces disposed coaxially around and along a z-axis extending in z-direction and symmetrically with respect to an origin, each of said shield coil surfaces being of radius a and of axial length d, said pair being mutually separated by a center-to-center distance $z_0$ which is greater than d; and

a pair of cylindrical shield coil surfaces disposed coaxially around said primary coils, each of said shield coil surfaces being of radius b which is greater than a;

said method comprising the steps of:

specifying a gradient coil current distribution related to said gradient coils as equal currents are caused to flow through said gradient coils;

obtaining a shield coil current distribution related to said shield coils as said equal currents are also caused to flow through said shield coils such that magnetic field outside said shield coils is cancelled;

expanding resultant magnetic field near said origin due to said equal currents by Fourier-Bessel series;

deriving from said calculated resultant magnetic field a linearity-establishing equation for obtaining a linear gradient around said origin; and

selecting a value of one of the parameters selected from the group consisting of d and $z_0$ to solve said linearity-establishing equation for the other of said parameters.

12.(amended) The method of claim 11 further comprising the step of approximating said shield coil current distribution by discrete conductor disposition on said cylindrical shield coil .

Please add new claim 20 as follows:

20.(new) The method of simultaneously achieving a desired RF gradient magnetic field within an inner cylindrical volume of radius a and a field free region outside of an outer coaxial cylindrical volume of radius b, said cylindrical volumes comprising an actively shielded extended Maxwell pair, said actively shielded extended Maxwell pair comprising:

a pair of cylindrical gradient coil surfaces disposed coaxially around and along a z-axis extending in z-direction and symmetrically with respect to an origin, each of said shield coil surfaces being of radius a and of axial length d, said pair being mutually separated by a center-to-center distance $z_0$ which is greater than d; and further comprising

a pair of cylindrical shield coil surfaces disposed coaxially around said primary coils, each of said shield coil surfaces being of radius b which is greater than a; said method comprising the steps of

specifying a magnetic gradient field distribution in a first cylindrical region of radius a and axial extent inclusive of said center-to-center distance $z_0$,

requiring a null RF magnetic field condition in an annular cylindrical volume region coextensive with said first cylindrical region, said annular region of external radius b and internal radius a,

deriving a linearity establishing condition from said steps of specifying and requiring, whereby a linear gradient is established in said first cylindrical region,

calculating a gradient coil current distribution to produce the magnetic gradient field distribution of said step (a) and simultaneously obtaining a shield coil surface current distribution consistent with step (b), said integral of each said current distribution being identical,

approximating said current distributions with axially discrete current loops, and

energizing each said approximated current distributions.

Sub C1